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Reading, May 21 2019

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

EXCELENCIA SEVERO OCHOA

EC-Earth land surface model : development of the offline configuration and application to decadal prediction of wildfires

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Lund University partners

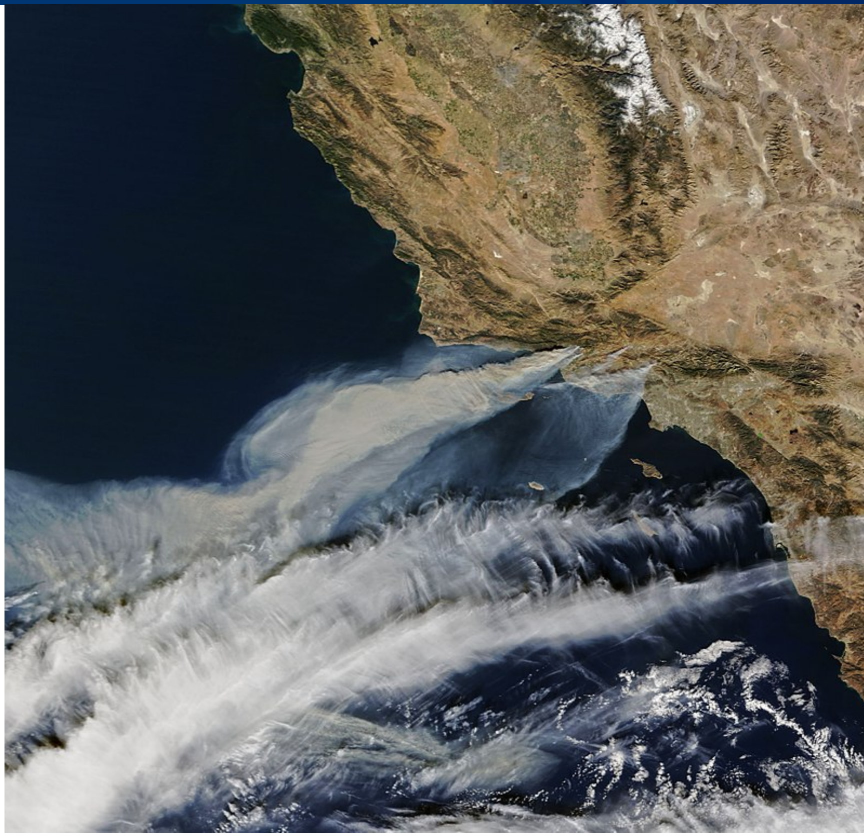
Introduction

The 2017 fire season in California WAS the costliest on record, with 18 Billion US$ in damages, and deadliest with 43 casualties on record.

2018 wildfire season was even worse...

REX/Shutterstock

California 2017 wildfires



In October, around the Napa valley in Northern California, the Tubbs fire was the most destructive in US history. Warm temperatures and strong winds are thought to be responsible for the severity of these wildfires.

In December, Southern California was plagued by severe wildfires and the Thomas fire near Los Angeles became the largest in California history. It was thought to be fueled by sever Santa Ana winds and warmer than average temperatures.

Iberia 2017 wildfires

In June 2017, the infamous “Pedrogão Grande” wildfires (in central Portugal) killed 62 people trapped in their cars are they fled the intense wildfires.

https://www.cnn.com/2017/06/18/europe/portugal-fire/index.html

Iberia 2017 wildfires

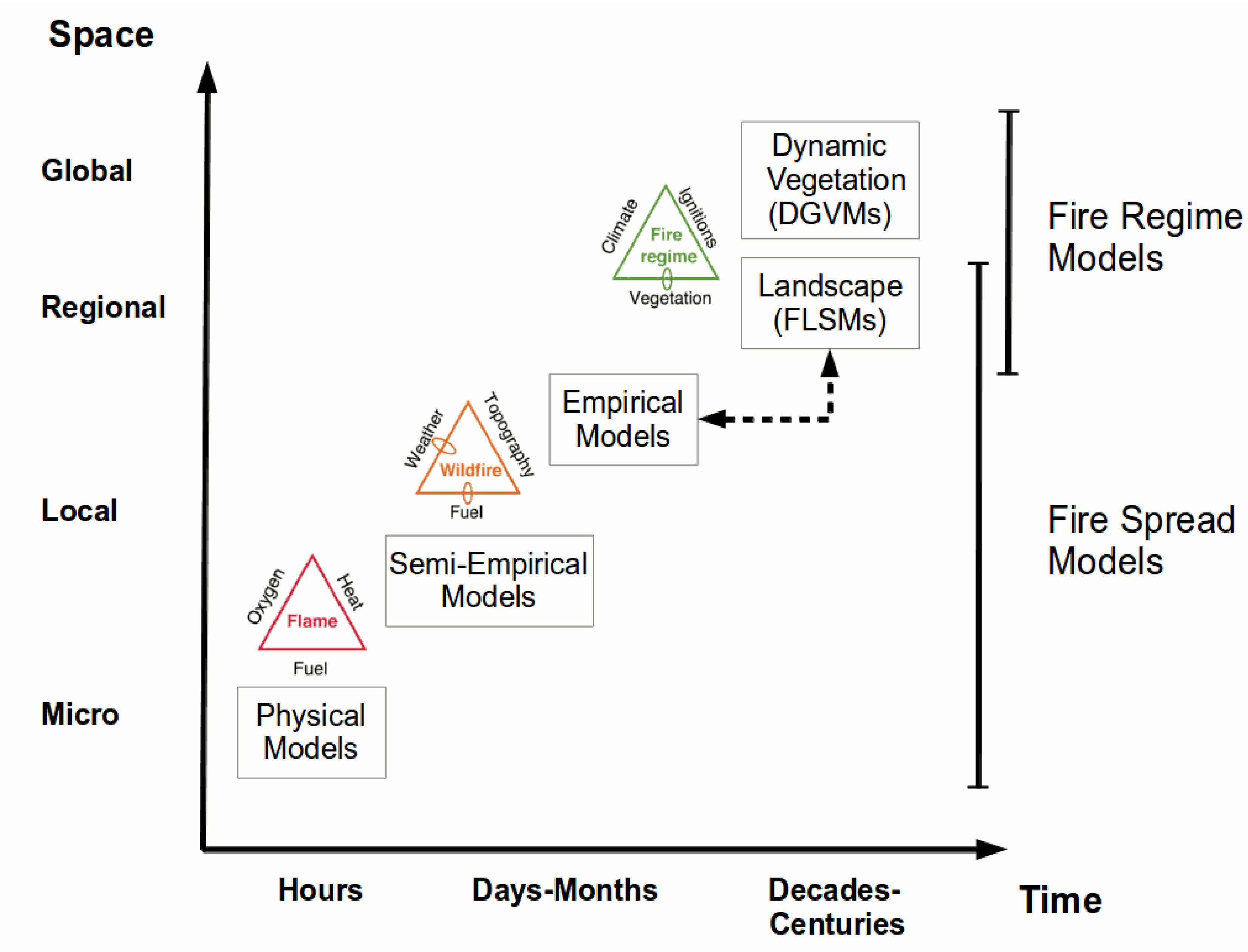
In October 2017, wildfires raged across northern Portugal and Galicia (Spain). The wildfires were made possible due to an intense drought and fueled by intense winds from Hurricane Ophelia. Arson is believed to be responsible for igniting many fires.

https://www.nytimes.com/2017/10/16/world/europe/portugal-spain-fires.html

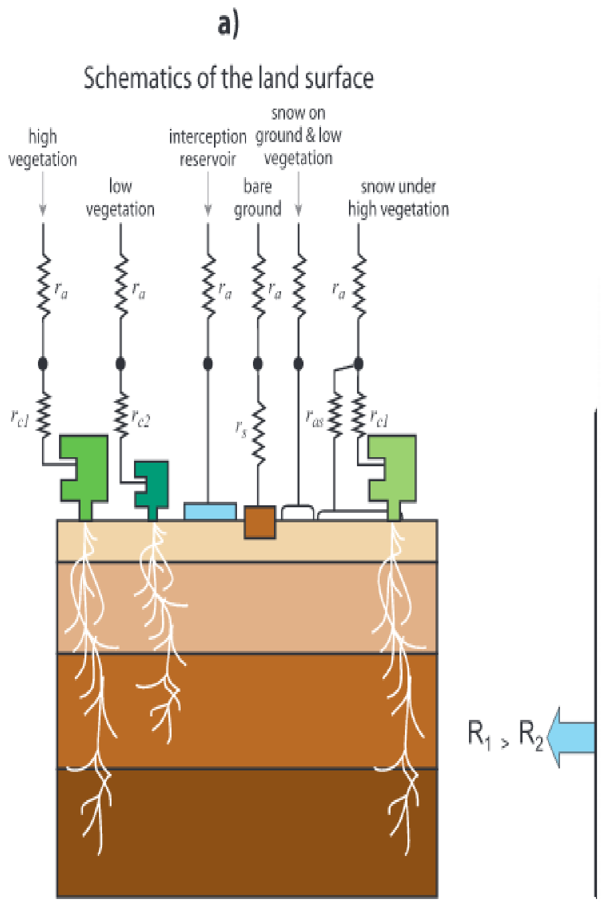
SPFireSD

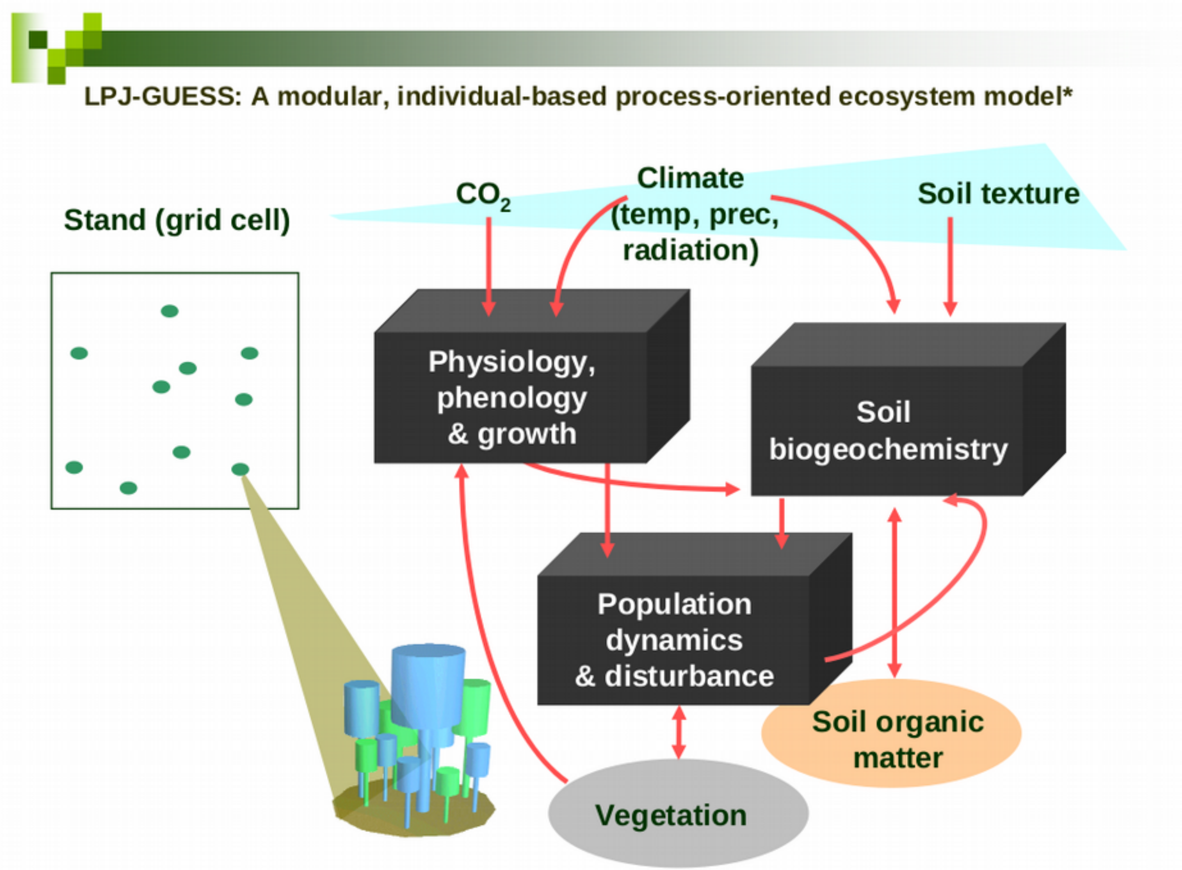
- Seasonal Prediction of Fire danger using Statistical and Dynamical models (SPFireSD) is a MARIE SkŁodowska-CURIE ACTIONS Individual Fellowship (MSCA-IF)
- SPFireSD proposes to develop and assess seasonal fire prediction capability through a variety of complementary and innovative methods using statistical and dynamical models, with a focus on Europe, the Amazonian basin and Indonesia.
- This project will develop and assess seasonal prediction capability of wildfire danger using three complementary approaches:
  - 1) **Fire danger indices approach**: simple fire danger indices computed from seasonal dynamical climate prediction systems
  - 2) **Statistical approach**: statistical fire danger models using a combination of past observational data and seasonal dynamical climate forecasts
  - 3) **Dynamical approach: ensemble dynamical predictions** using state-of-the-art fire models within Earth System Models (LPJ-Guess part of the EC-Earth Earth System Model)

Fire modeling across scales



H-TESSEL + LPJ-GUESS





*Smith et al. 2001 *Global Ecology and Biogeography* 10: 621

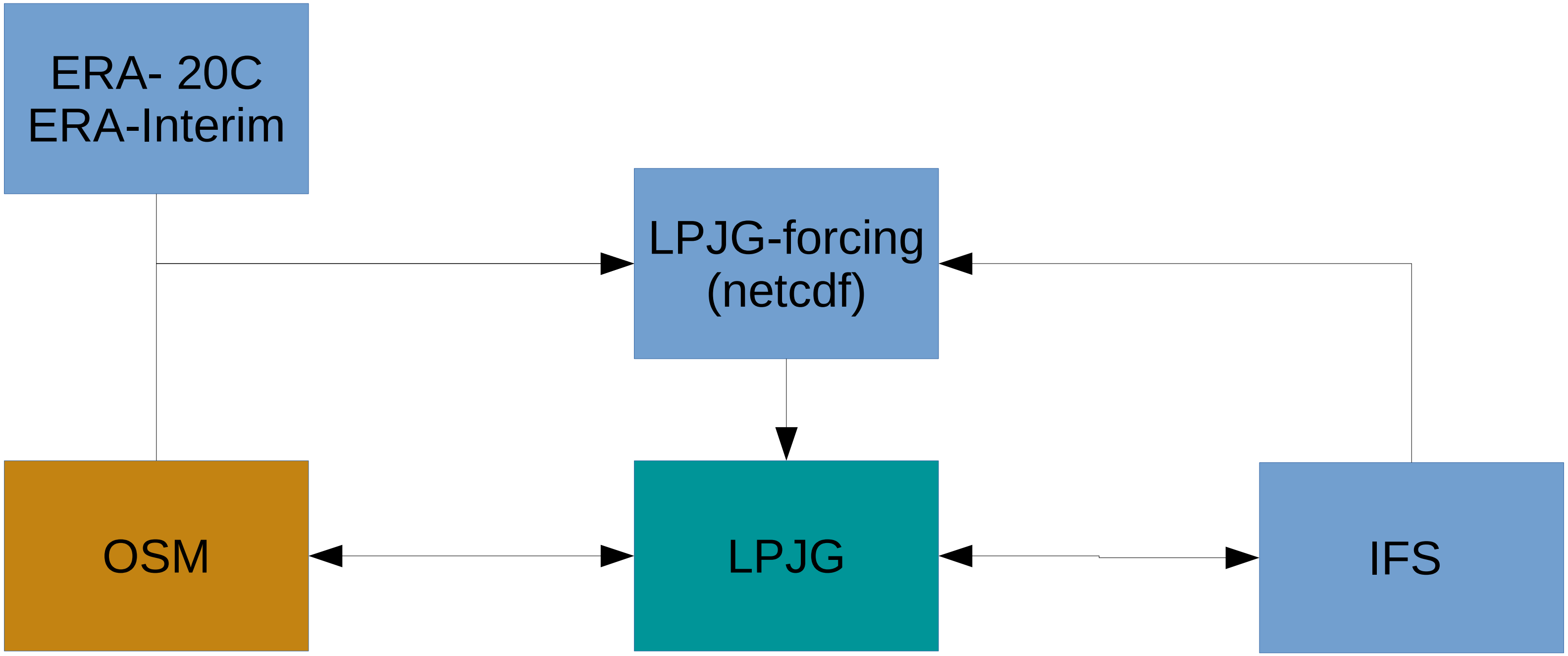
Offline LSM status

LSM (Land Surface Model) contains 3 components:

LPJG, as used in the ESM configuration

LPJG-forcing (aka Sparring), used to send atmospheric forcings to LPJG

OSM (Offline Surface Model), offline version of the IFS land surface model (H-TESSEL)



Offline LSM status

```
# ---------------------------------------------------------------------------
# *** General configuration
# ---------------------------------------------------------------------------
# Component configuration (for syntax of the $config variable, see librunscript.sh)
#
# Currently maintained:
#     config="osm"                    # OSM (Offline Surface Model, H-TESSEL forced by
IFS output)
#     config="lpjg lpjg_forcing:IFS"    # LPJG-Offline forced by IFS/OSM output
#     config="lpjg osm"                 # LPJG & OSM Coupled via OASIS
                                  # In this config lpjg can take the option:
                                  # lpjg:fdbck to feedback on the OSM

config="lpjg:fdbck osm"

# minimum sanity
has_config ifs && error "Cannot have ifs in config"
has_config nemo && error "Cannot have nemo in config"
has_config lpjg_forcing osm && error "Cannot have both lpjg_forcing and osm in config"

# libosm defines some OSM and LPJG pre/post-processing functions
has_config any osm lpjg_forcing && source ./libosm.sh
```

Offline LSM status

- WHY?
  - Easy tool for quick testing & validation
  - Requirements for CMIP6 (LUMIP, LS3MIP, etc.) & other projects
  - Development of new codes quick & easy
- History:
  - ??? Uwe, Paul Miller develop the Sparring, which simulates the IFS by sending and receiving data to LPJG via OASIS calls, Klaus develops script to convert IFS output to daily netcdf files
  - July 2017 – Dec 2017 : development of the initial ece-lsm.sh script by Etienne, with help from Paul, Lars & Peter Anthoni, merged into the initial ESM branch (issue #412)
  - Nov. 2017 – Jan 2018 : Development of the OSM by Emanuel Dutra "off-line HTESSEL model downgraded from openIFS (cy43r1)" (issues #380 #458)
  - July 2018 – Nov. 2018 : coupling htessel and lpjg by Emanuel Dutra (issue #572)
  - Nov. 2018 – today : bugfixes and optimizations, synced with 3.3.1 by Etienne, multiple resolution support (issues #555, #596)
  - Very soon in trunk

OSM validation – using IFS output

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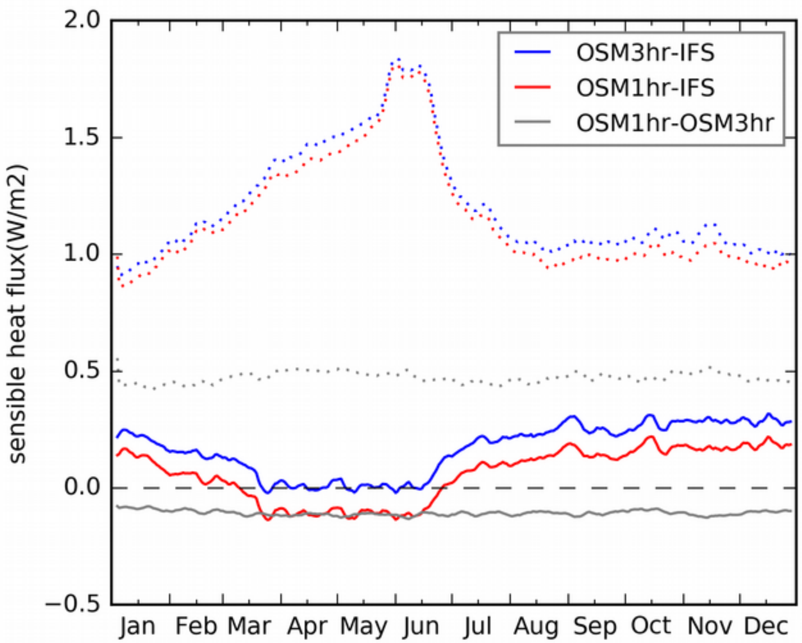

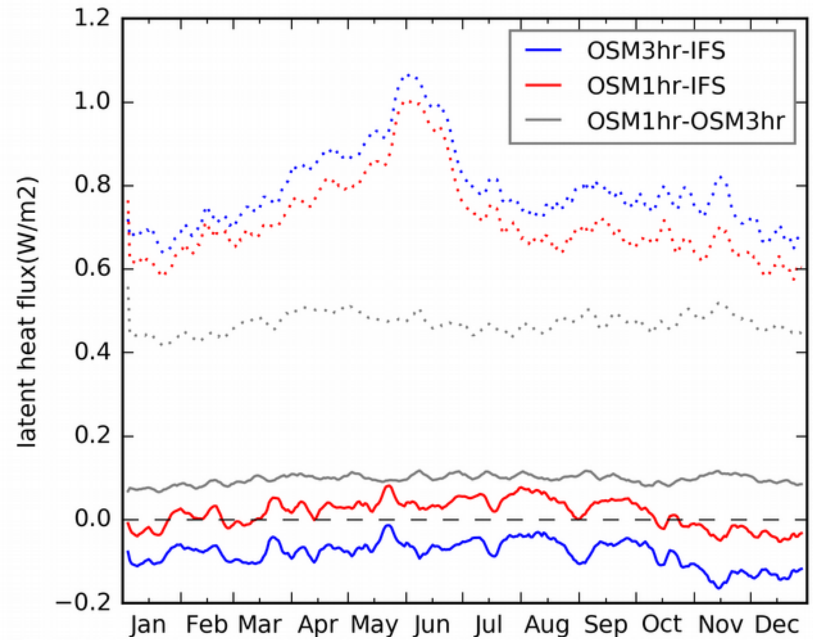

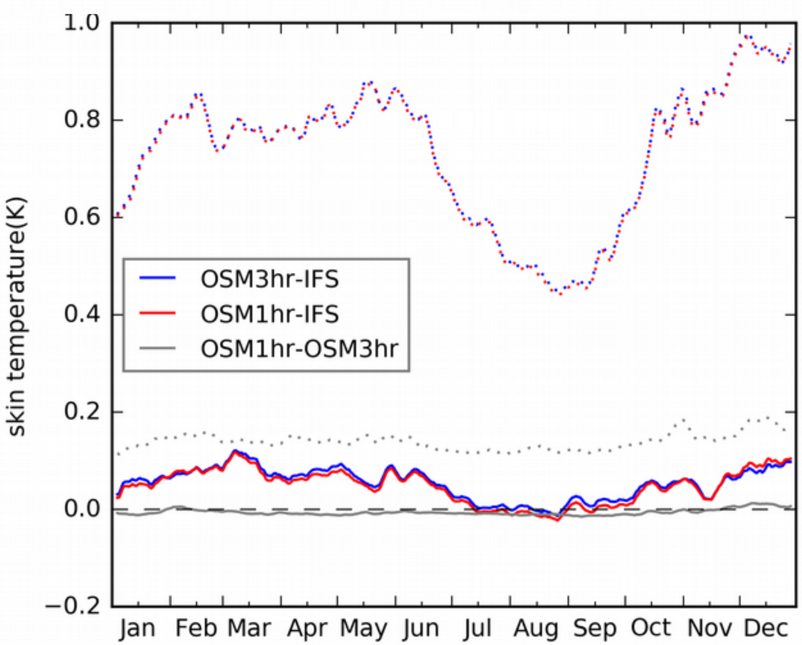

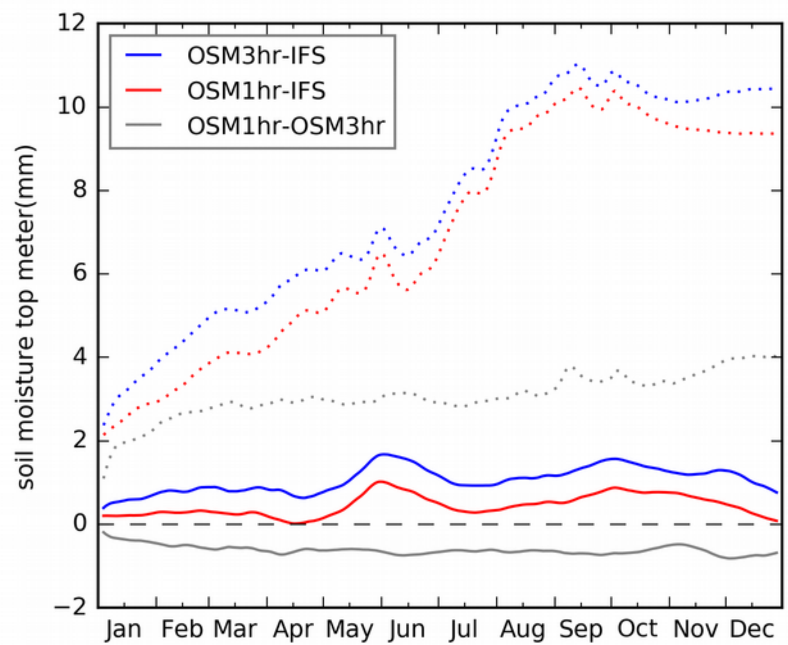

Offline LSM status

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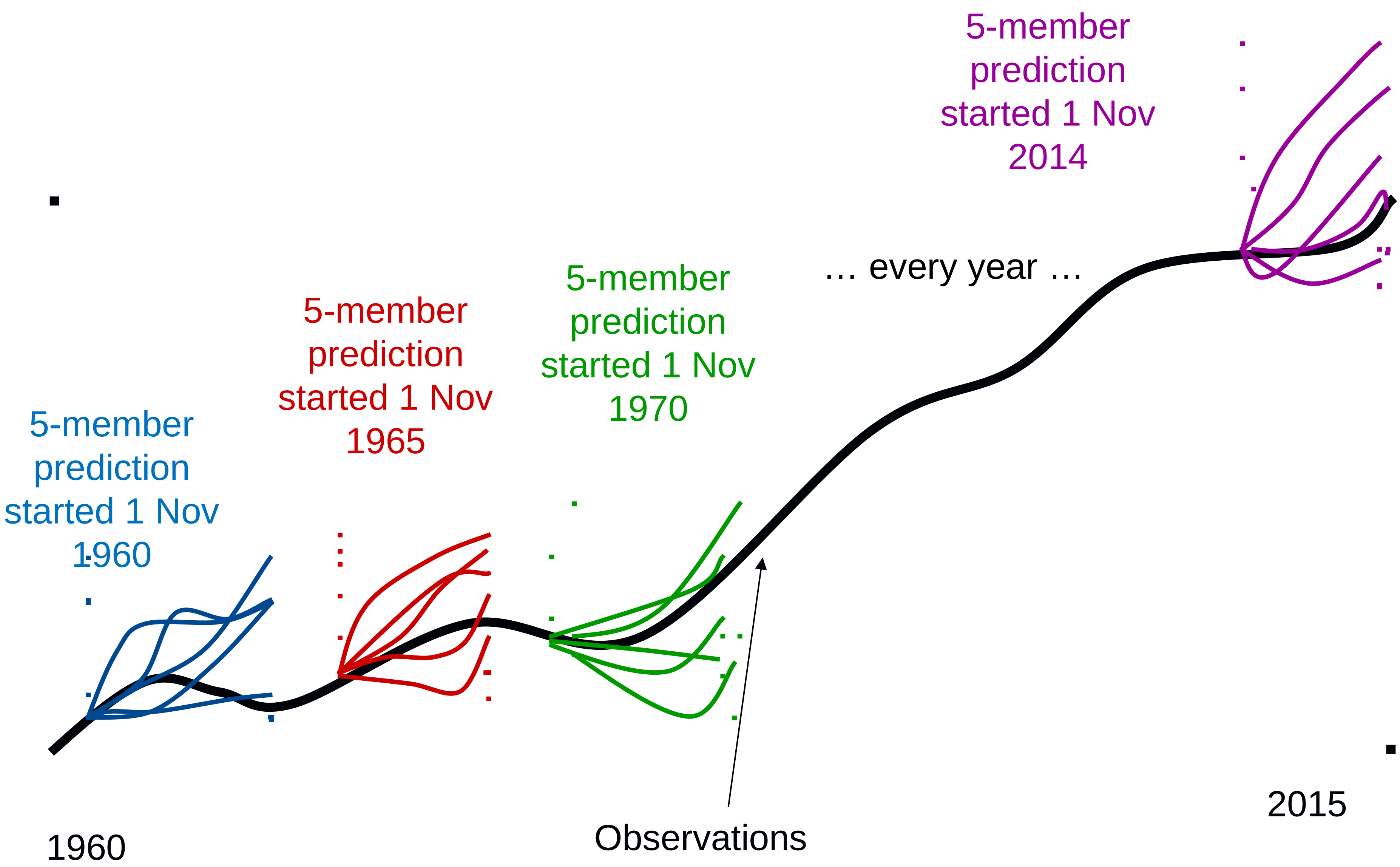
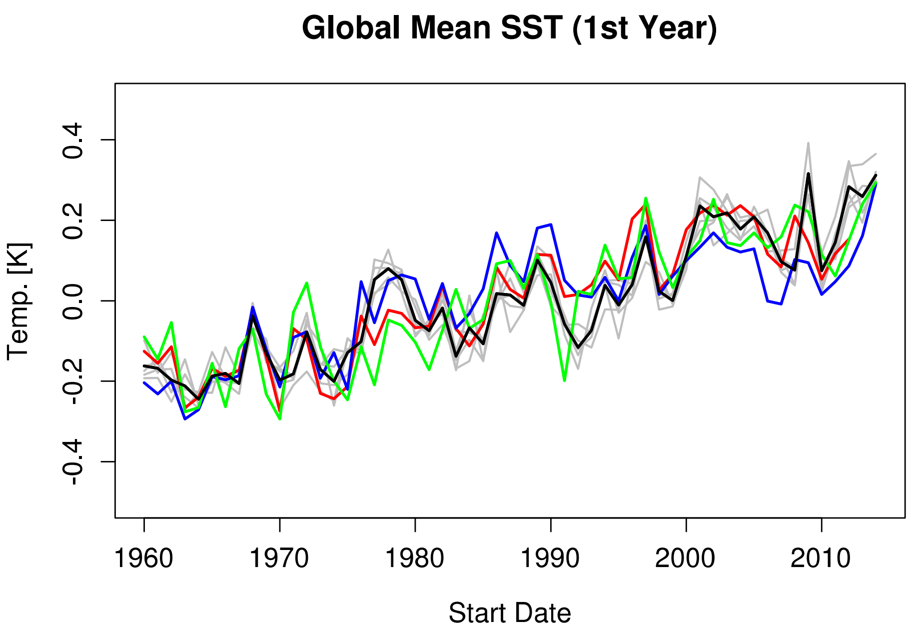
- Performance (on Marenostrum4):
  - LPJG only:
    - 30 minutes/year initially
    - 7 minutes/year after I/O opt + compressed output
  - OSM only: 10 minutes/year
  - LPJG + OSM : 15 minutes/year
- The Future of LSM development
  - Pending merge into trunk: LPJG vendor drop for compressed output, correct bug found in OSM→ LPJG
  - scientific validation & testing by others
  - Integration of LS3MIP changes into surf/offline
  - Use in CMIP6 : LS3MIP, LUMIP & DCPP/CCiCC

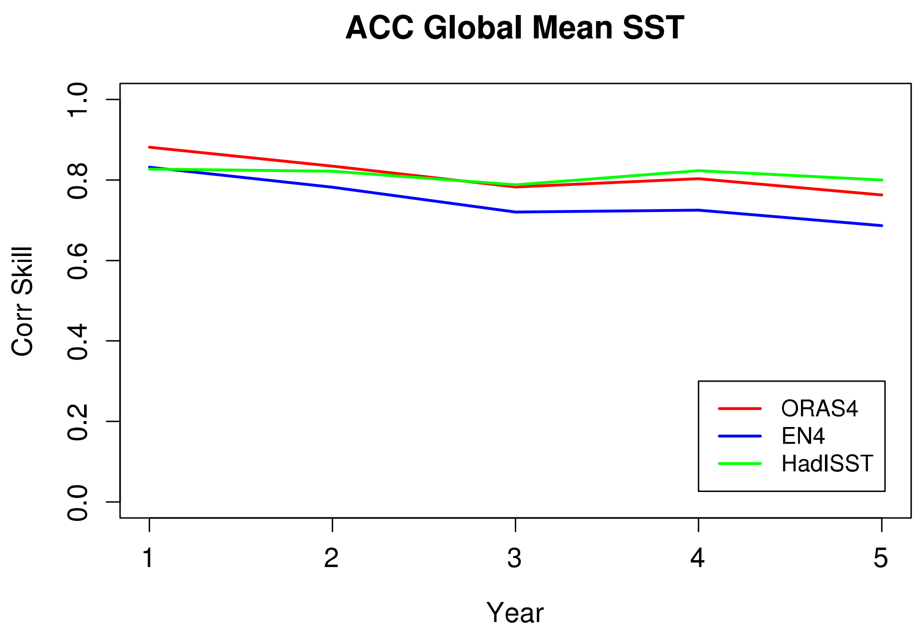
Climate prediction experiments



Climate prediction experiments

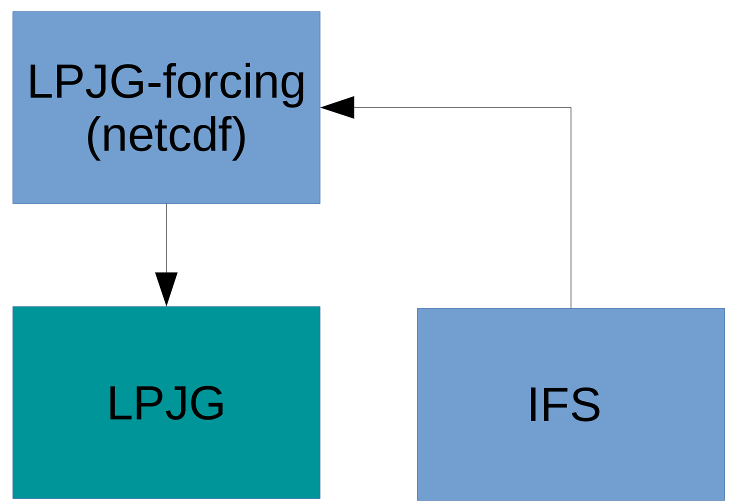
- DCPP LPJG-offline experiment :
  - LPJG initial states from Klaus’ t613 run (EC_Earth-Veg)
  - Daily output from BSC’s DCPP hindcasts (1960-2015), 5 years, 5 members
  - Allows to test the fire model before doing fully-coupled decadal hindcasts of the carbon cycle (CCiCC)



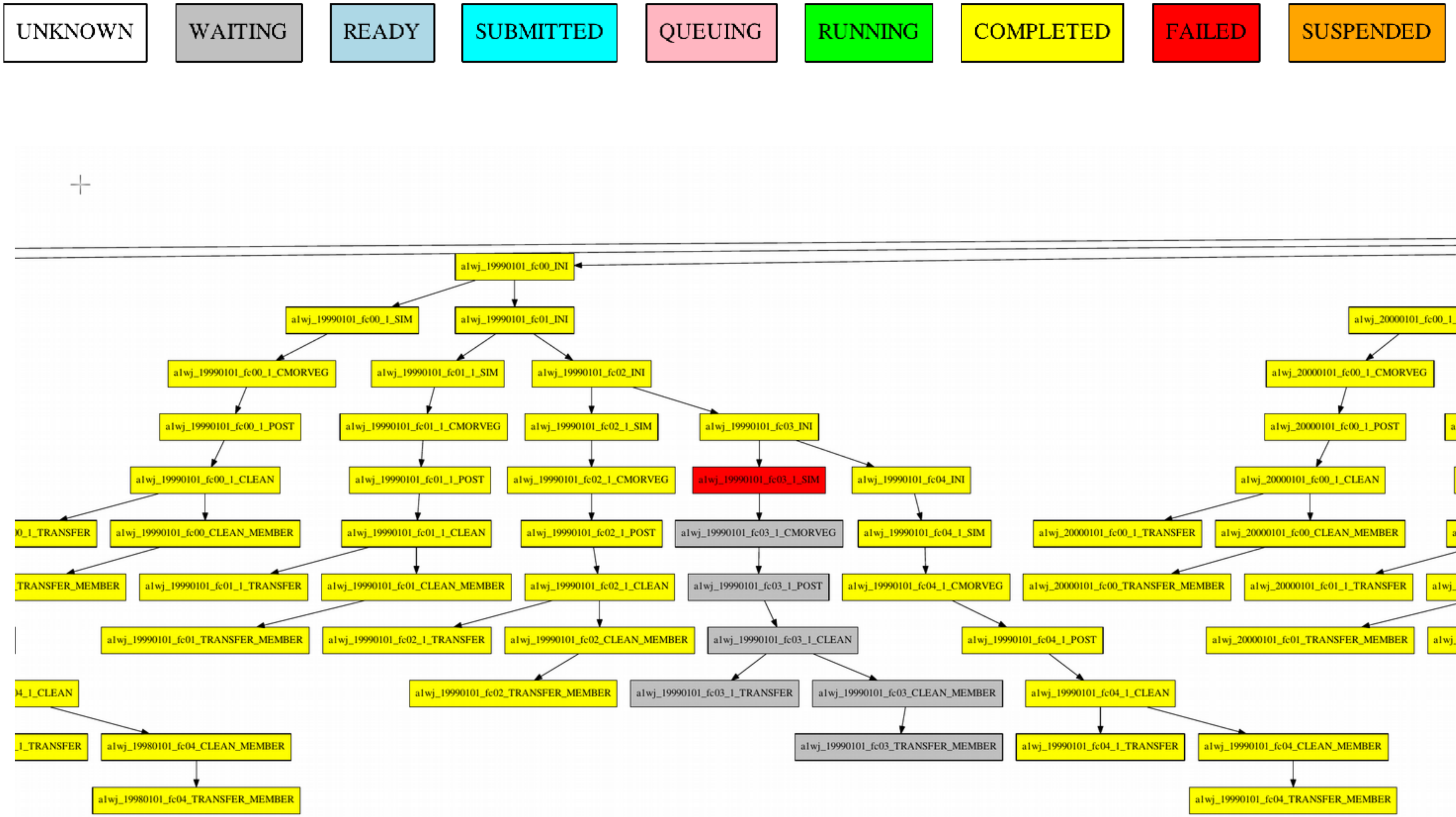


Climate prediction experiments

- DCPP LPJG-offline experiment (a1wj):
  - LPJG states from Klaus' t613 run (EC_Earth-Veg)
  - Daily output from BSC's DCPP hindcasts (1960-2015), 5 years, 5 members
  - 1 hour to run 5 years on 2 nodes
  - 1 hour to CMORize on 1 node!!!



Climate prediction experiments



LPJG-offline runs - 1st year DCPP

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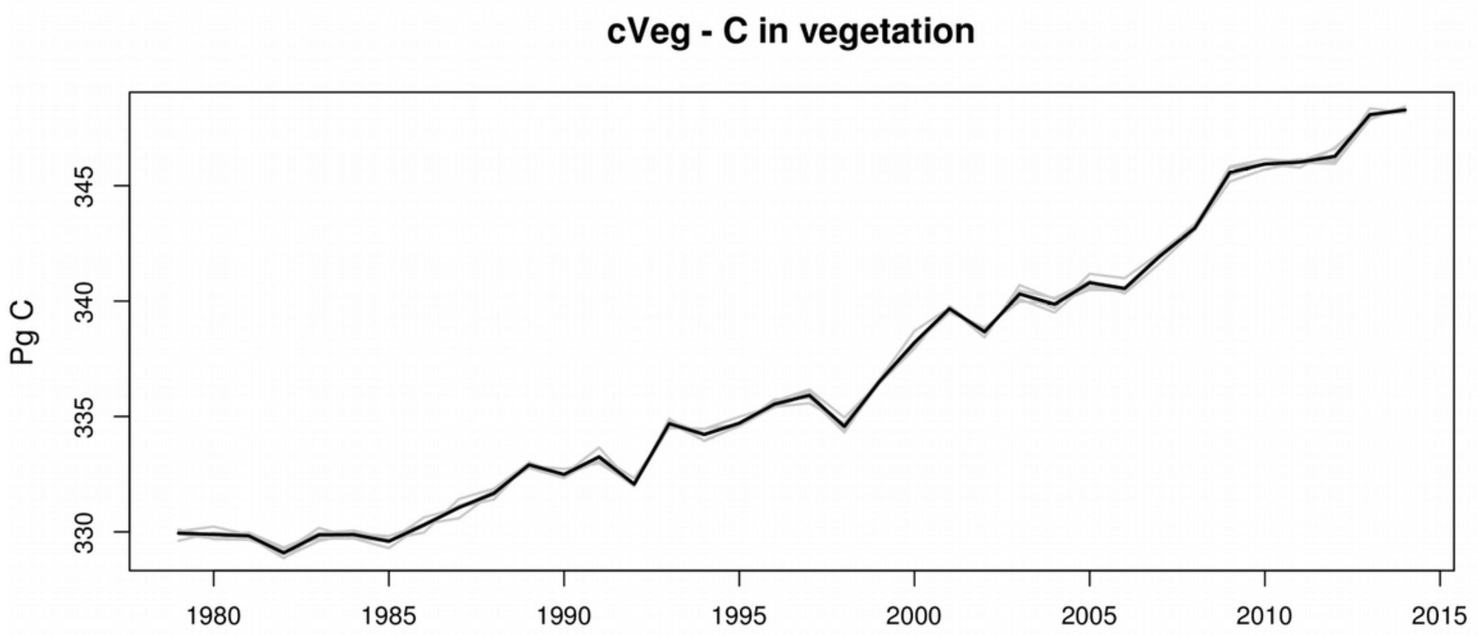
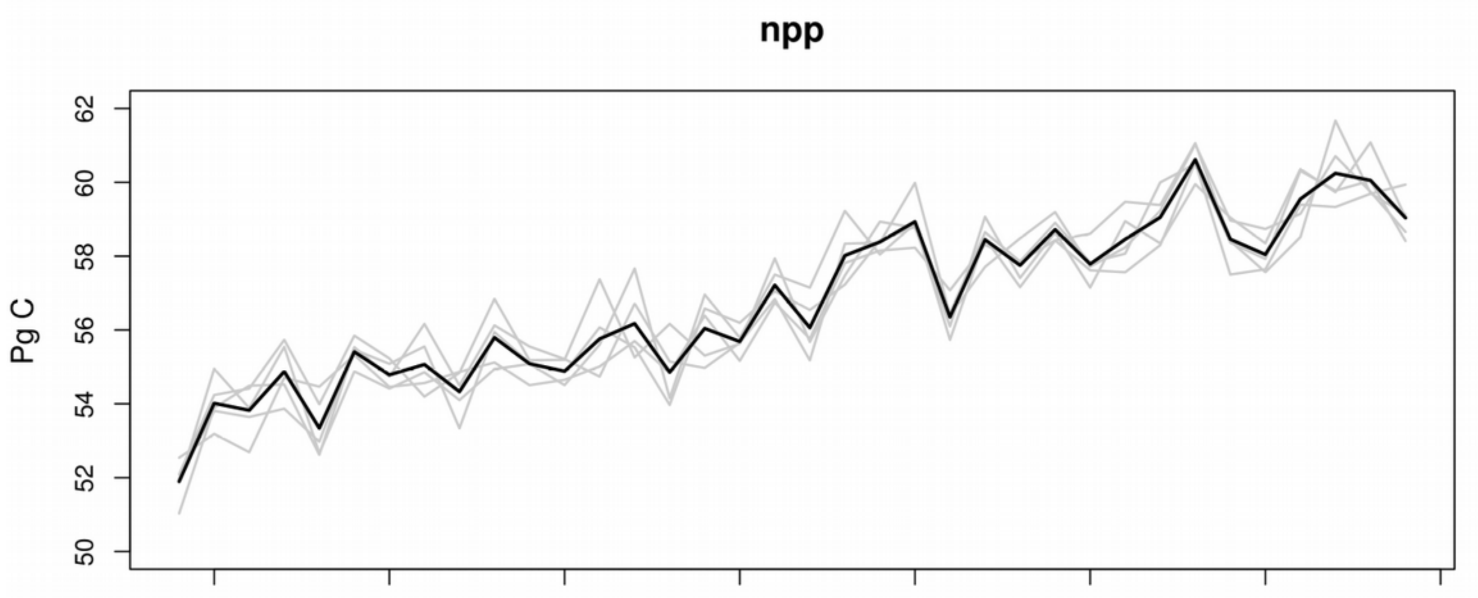
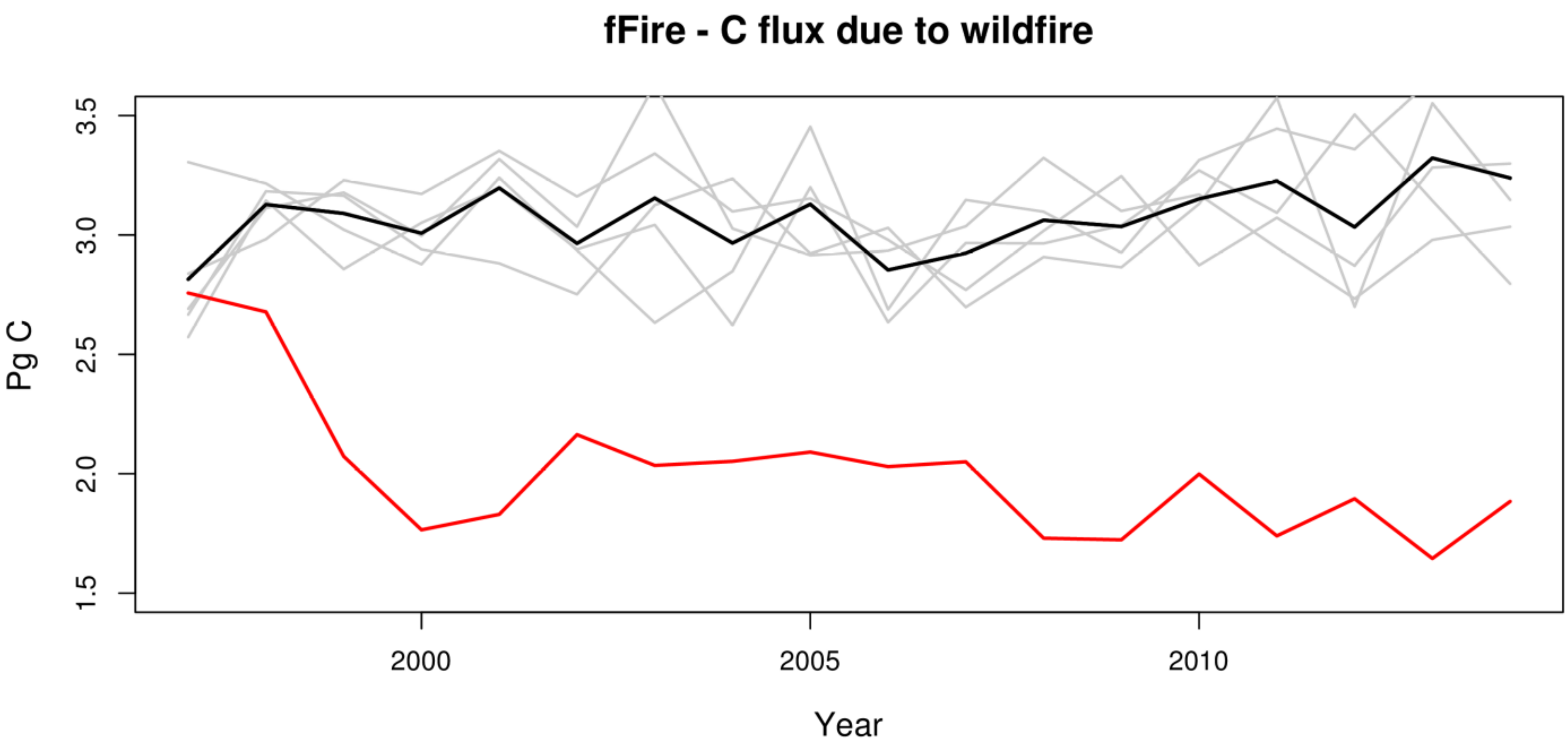




1st year DCPP vs. GFED emissions



State of the art Wildfire models

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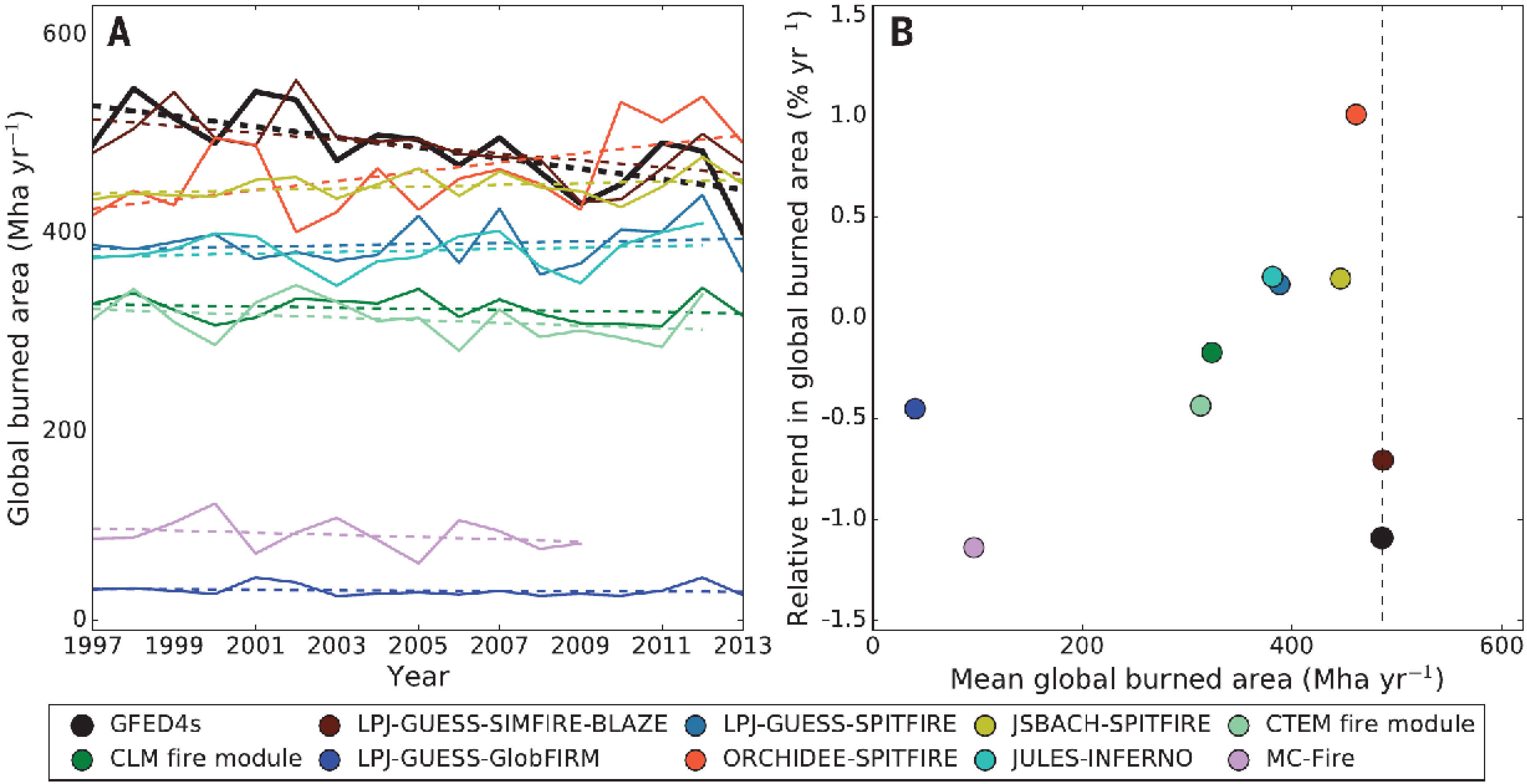
Comparison of burned area simulated by several offline fire models (FIREMIP)

Current model in LPJG is the worst – GlobFIRM
The best is SIMFIRE-BLAZE – soon in our LPJG version!



Offline LSM status

- The Future of LSM development
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  - scientific validation & testing by others
  - Integration of LS3MIP changes into surf/offline
  - Use in CMIP6 & beyond : LS3MIP, LUMIP & DCPP/CCiCC
- Future work in wildfire modeling
  - In-depth analysis of results, compared to (few) observations
  - Compare to offline runs driven by reanalyses
  - Integrate better fire models with help from partners in Lund University - SIMFIRE/BLAZE
  - Use these new models in offline decadal hindcast runs – very cheap!

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Thank you!

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MARIE CURIE ACTIONS

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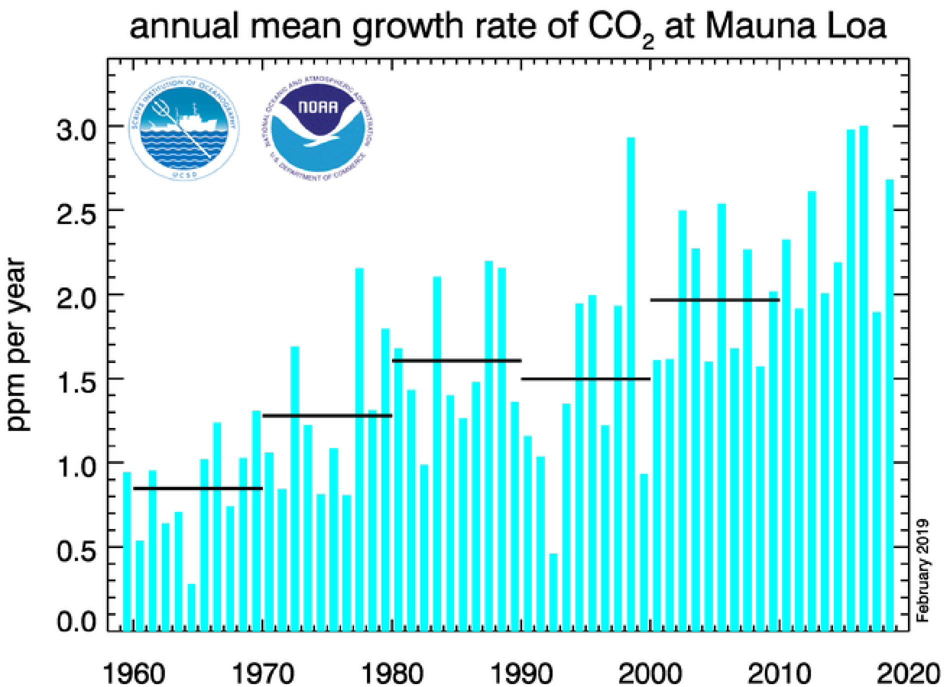
CCiCC

Towards a near-term prediction of the climate and carbon cycle interactions in response to Paris Agreement emission trajectories

Variability in atm CO2 growth rate is mostly due to natural variability



Testing different ocean biogeochemical reconstructions as initial conditions

Retrospective decadal predictions of ocean and land carbon uptake

Idealized perfect-model experiments to investigate mechanisms of C uptake predictability in the ocean.